

limited intelligence, the forces to which they are due seem to have been constantly directed in their course. The human mind is more disposed to accept the idea of guidance than that of predetermination, as it seems to us to be the less impossible of the two, and the more easy to understand. We ourselves wait upon circumstances; we see how things are going to shape before we move, and we fancy that the world must have been made, and must be carried on, on the same principle. But the study of nature gradually causes this belief to fade away. The more we learn the more we see that secondary law extends much further than we had expected, and we begin to think that all may be due to secondary laws.

We cannot doubt but that the most complicated cases of inheritance—such as the growth of the train feathers of a peacock, or the gorgeous wings of a butterfly—are due to secondary laws, although the processes are quite incomprehensible to us. We believe these to be due to secondary laws, because we see them taking place in exactly the same order over and over again; and in the case of the peacock we know that if we pull out the feathers, new ones, similar to the old, will replace them. So that we can bring these laws into play whenever we choose. It is not sufficient, therefore, to say that an action is not due to secondary law, because it is so wonderfully intricate, or because it is incomprehensible to us. We must be able to show, either that the action is antagonistic to known natural laws, or that the result could not be due to a combination of any natural laws that we have already discovered. That is, we must show a discontinuity in the phenomena. Can any such breaks be discovered?

The origin of the material universe, which was the starting point of the present evolutionary process, appears to us to have been a new departure in natural law. But we cannot feel certain about it, for we do not know, and never can know, what went before. But with the origin of life on the earth it is different. The intimate structure of organic beings, as well as their order of development on the earth, point to the conclusion that they are all derived from a common ancestor, and that living protoplasm was formed once, and once only, on the surface of the sea. Now, in the origin of living substance on this planet we have a case which is generally recognised as a break in continuity. It is generally allowed that it was an action which is not only incomprehensible by us, but one which conflicts with our knowledge of natural laws. That an unstable chemical compound, endowed with the power of directing energy independently of any outside agent, should have been brought into existence by the action of known physical laws is an impossibility. The processes of assimilation and fission, on which all progress depends, are quite distinct from anything which had gone before. And as every living cell is imbued with what we call instinct, which directs its energies, it follows that in physiology action and reaction are not equal and opposite. Indeed, every organism inherits from its parents a store of energy which directs growth and which appears to be inexhaustible. It is drawn upon during the whole period of growth, which, in some plants, lasts all through life, and yet abundance is left for transmission to its offspring, no matter how numerous they may be. The store increases instead of diminishes, and we cannot tell why. Until some explanation can be given, it is not only permissible, but reasonable, to view the origin of life as due to some guiding action of natural law, especially when we remember what that break in continuity has led to.

Again, it has been often pointed out that the genesis of consciousness is as great a mystery as the genesis of life, and that it seems to be equally opposed to the law of conservation of energy. In the lower animals, and in some of the lowest plants, we see physiological processes producing movements which appear to be intelligent, but which, in reality, are no more so than the movements of the leaves of a sensitive plant. And it is generally allowed that for the exhibition of consciousness a brain-cortex is required; but how matter in the brain-cortex becomes self-conscious we cannot understand. However, it is possible to suppose that mind is a necessary concomitant of life, so that the origin of the two may be one and the same problem. Also, as consciousness may be lost—as in habit—and regained by attention, it is possible that consciousness may be a constant function of mind, but one that cannot become efficient until a large number of specially formed cells are accumulated in a brain-cortex. I cannot, therefore, see that the genesis of consciousness in animals necessarily marks a break in continuity, notwithstanding that its origin is quite incomprehensible to us.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Proposals have been laid before the Senate for modifying the principles of classification in the natural sciences tripos, though the proposals are not unanimously acquiesced in by the boards concerned. In part i., in which at present the aggregate mark in three or four sciences governs the class, it is suggested that weight should also be given to the candidate's particular performances in each subject. In part ii., a candidate is required, for a first class, to take at least one primary and one subsidiary subject; it is proposed to abolish the requirement of a subsidiary subject. It is further proposed that human anatomy and vertebrate comparative anatomy should in future be reckoned as a single subject in this part of the tripos. These changes, if approved, are to come into effect in 1904.

Earl Spencer, K.G., has been appointed an elector to the professorship of agriculture in the place of the late Sir J. H. Gilbert, F.R.S.

UNDER the will of the late Dr. Nathaniel Rogers, the Senate of the University of London offer a prize of 100*l.*, open for competition to all the members of the medical profession in the United Kingdom, for an essay on "The Production of Immunity in Specific Infective Diseases—generally, and with particular Reference to any one Disease on which the Writer of the Essay may have made Original Investigations." Essays must be sent in not later than February 28, 1903, addressed to Mr. Percy Wallace, secretary to the Senate.

THE report of the executive committee of the Carnegie Trust for the Universities of Scotland on the administration of the trust for the period from June 7, 1901, to December 31, 1901, was read and passed at a meeting of the trustees last week. For the winter session 1901-2, the sum of 22,941*l.* 16*s.* 6*d.* was paid by the trust up till December 31, 1901, on behalf of 2441 students, representing the fees of 7610 classes. The committee, in accordance with the expressed desire of Mr. Carnegie, did not make question respecting the circumstances of applicants; but from information voluntarily offered by applicants themselves, they have ample assurance that in a large number of cases the payment of class fees has proved a boon of the greatest value to deserving students, and many acknowledgments of the letter sent to the parents and guardians of applicants express gratitude for the timely assistance rendered by the Trust. The class fees paid and the number of students were as follows:—St. Andrews, 268 students, class fees, 2452*l.* 16*s.*; Glasgow, 828 students, class fees, 7672*l.* 13*s.* 6*d.*; Aberdeen, 473 students, class fees, 3806*l.* 1*s.* 6*d.*; Edinburgh, 872 students, class fees, 9010*l.* 5*s.* 6*d.*

MR. J. H. GARTSIDE has given to the Owens College, Manchester, the sum of 10,000*l.*, which has been applied in the purchase of an annuity of 1163*l.* a year for ten years, payable to the college, to be used for the provision of scholarships, which are to be known as "The Gartside Scholarships of Commerce and Industries." The scholarships are intended to induce young men who have already received a good education to devote a year at least in Owens College to the special study of subjects bearing on commerce and industry, and then to go abroad for the study of some particular subject, either in Germany or the United States, or some other country approved by the electors to the scholarships. The emoluments of the scholar while in England will be about 80*l.* a year, but when travelling abroad a larger sum will be given, which in the case of scholars travelling in the United States will probably be about 250*l.* per annum. The scholars are to furnish reports of their investigations in the foreign countries which they visit. These scholarships are intended by Mr. Gartside to be an incentive and assistance to those who contemplate a careful study of commercial and industrial methods, and should enable useful information to be obtained with regard to these subjects, both in America and on the Continent.

AT the annual general meeting of the members of University College, London, held last week, Lord Reay moved the following resolution on behalf of the council:—"That this meeting has heard with great satisfaction of the generous offer of the Drapers' Company to make themselves responsible for the debt upon the college to the extent of 30,000*l.*, and of another friend

of the college to give an equal sum, conditionally upon the college being incorporated in the University of London, and concurs in the resolution of the council to enter into negotiation with the University with a view to the incorporation." He said the idea of incorporation was not a new one, because when the statutory commissioners were sitting for the purpose of framing the statutes for the reconstitution of the University of London, the council represented to them the intention of the founders and benefactors of University College would only be carried out by incorporation. The commissioners, however, felt that the terms of the Act did not make it possible for them to give effect to the proposal. The council had not abandoned the policy, and since the beginning of the present year events had taken place that brought it within the range of speedy realisation. With regard to the appeal for funds, it was quite obvious that if the work which was being carried out was to be continued, the funds would need a much larger increase. Lord Monkswell, who seconded the resolution, hoped there would be many rich men who would follow the example of their anonymous benefactor. He trusted that the negotiations which they were having with the University of London would be successful, and said that no conciliatory efforts on their part would be wanting. The resolution was adopted.

THE address delivered before the Association of Technical Institutions on January 31, by the president, Lord Avebury, is published in the official report of the proceedings of the meeting. The address was, in a large part, a plea for more liberal recognition of science and modern languages in the time-tables of our schools, supported by the opinions of commissions and other competent authorities. Classics has at present too large a portion of the available time, and science is only tolerated. "An education which excludes science is a one-sided education, and the most learned classical scholar, if he knows nothing of science, is but a half-educated person after all." But the question is not so much one of culture as of equipment for national progress. When, as Lord Avebury remarks, we find commission after commission (composed of men selected for their wisdom and experience), after careful and patient inquiry, one after the other, and with remarkable unanimity, pointing to the neglect of science and of modern languages in our educational system as a grave evil, it must surely be worth while to inquire whether these warnings have been taken to heart, or the recommendations have been carried into effect. Lord Avebury gives instances, most of which are known to readers of NATURE, of industrial progress in Germany due to technical training. "It is evident then," he concludes, "that the technical instruction of Germany has been a very remunerative investment; in the first instance, no doubt, a great national advantage, but a boon also to the world as a whole. These figures bring home to us clearly the importance of the subject. It is obvious how keen competition is going to be. If we are to hold our own, we must supplement the rule of thumb in our workshops—very important in itself—by the rule of brain. Emerson once said that this country 'is prosperous because steam is half an Englishman.' We all hope that Britannia may long rule the waves, but it is most important that she should rule the steam engine and the dynamo as well."

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xxiv. No. 1, January. —Cyclic subgroups of the simple ternary linear fractional group in a Galois field, by L. E. Dickson. This paper is an addition to the author's previous one in vol. xxii. pp. 231–252. It gives proofs of results therein stated and adds some new theorems allied to them. The question discussed concerns the substitutions

$$x^1 = a^r x, y^1 = a^s y, z^1 = a^{-r-s} z,$$

where a is a primitive root of the Galois field of order p^n . Two cases arise according to the value of the greatest common divisor d of 3 and $p^n - 1$. —Curves of triple curvature, by J. G. Hardy. The object of the paper is to add to the results which have been obtained concerning curves L of triple curvature. Equations of motion for systems in a four-dimensional space have been deduced and used to introduce the notion of an instantaneous plane of rotation. The derivation is not new, but it is retained for the sake of clearness. By constructing the principal tetrahedroid at a point of a curve of triple curvature and studying its motion by means of the kinematical equations obtained, geometrical

interpretations of the six rotations and also a set of formulæ corresponding to the Serret-Frenet formulæ for curves of double curvature have been arrived at. These formulæ have been applied to the study of curves L and, in particular, of the osculating hypersphere and the locus of its centres. Many of the results were contained in a paper read before the mathematical seminary of the Johns Hopkins University in 1898, and so were antecedent to the articles by Prof. Lovett and Mr. Hatzidakis in vol. xxii. The subject may be studied in Brunel, *Math. Ann.* xix. p. 48; Pironi, *Giom. di Mat.* xxviii. p. 237; and Piccioli, *Giom. di Mat.* xxxvi. p. 273. —Primary prime functions in several variables, and a generalisation of an important theorem of Dedekind, by H. Hancock. Reference is made to Kronecker, "Grundzüge," &c., § 4, p. 11; Runge, *Crelle*, Bd. xcix. p. 89; Mandl, *Crelle*, cxiii. p. 252; Meyer, *Math. Ann.* Bd. xxx. p. 39, and to other memoirs. —On certain properties of the plane cubic curve in relation to the circular points at infinity, by R. A. Roberts. In this second part, which is on certain plane cubic curves and their angles of intersection, with some account of conics cutting orthogonally, the author investigates some methods of generating certain plane cubic curves in such a way that their angles of intersection assume a simple form. —Estimate of Peirce's linear associative algebra, by H. E. Hawkes. In the fourth volume of the *Journal* there appeared a memoir by Peirce in which he attempted to classify and enumerate hyper-complex number-systems. This does not seem to have received on the Continent the credit it deserves. In order that it should receive due recognition, Mr. Hawkes claims that three questions must be discussed, viz., what problem did Peirce attack, and to what extent did he solve it? what relation does this problem bear to that treated by Study and Schefers? and to what extent do Peirce's methods assist in the solution of that problem? In the present article, Mr. Hawkes discusses the first two questions, and discusses the last in the *Transactions of the American Mathematical Society*, vol. iii. A historical review accompanies the article. It may be remembered that Mr. Spottiswoode drew attention to Peirce's work in his presidential address before the London Mathematical Society (vol. iv. p. 152); see also Cayley, "Collected Works," xi. p. 465; xii. p. 465. —Dr. G. A. Miller furnishes a short note on groups defined by the orders of two generators and the order of their product. —A fine portrait of Prof. Benjamin Peirce is given with the number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1901. —"The Effective Temperature of the Sun." By W. E. Wilson, D.Sc., F.R.S.

In a memoir by the author and Mr. P. L. Gray, entitled "Experimental Investigations on the Effective Temperature of the Sun," published in the *Phil. Trans. Roy. Soc. A* vol. clxxxv. (1894), the method described was as follows:—A beam of sunlight reflected from a Stoney single-mirror heliostat was directed into one aperture of a Boys' differential radiometer. The other aperture received the radiation from a small circular area of a strip of platinum raised to any desired temperature by an electric current, this temperature being measured by the linear expansion of the platinum as in Joly's maldometer. Knowing then the ratio of angular diameter of radiating area of platinum to that of sun, the temperature of the platinum strip, the emissivity of bright platinum, and the amount of the sun's radiation lost by absorption in the earth's atmosphere and by reflection from the heliostat mirror, it is possible in any assumption of a law connecting radiation with temperature to determine the effective solar temperature. The mean of a series of very accordant observations gave 6200° C. (absolute).

To protect the incandescent strip from draughts of air it was covered with a water-jacket of gilded brass. Possibly some of the radiation from distant parts of the strip may have been reflected between the polished walls and the strip itself and, ultimately escaping through the circular aperture fronting the radiometer, reached it and so vitiated the result. Smoking the interior of the water-jacket sensibly reduced the amount of radiation and so proved this surmise correct.

It is also possible that changes in the surface condition of the platinum may effect its emissivity, which in the original memoir was taken at 0.35 that of lamp-black (Rosetti's estimate), so that it is a distinct advantage to abolish the platinum strip as a source of radiation and to substitute a uniformly heated enclosure which would radiate as an absolutely black body.